National Transportation Safety Board

Fatigue: A Multi-Faceted Challenge

Christopher A. Hart, NTSB Member

Boeing Flight Operations Safety Stand-Down

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Topics

- NTSB basics
- Challenges of fatigue
- Facets of fatigue
- Examples

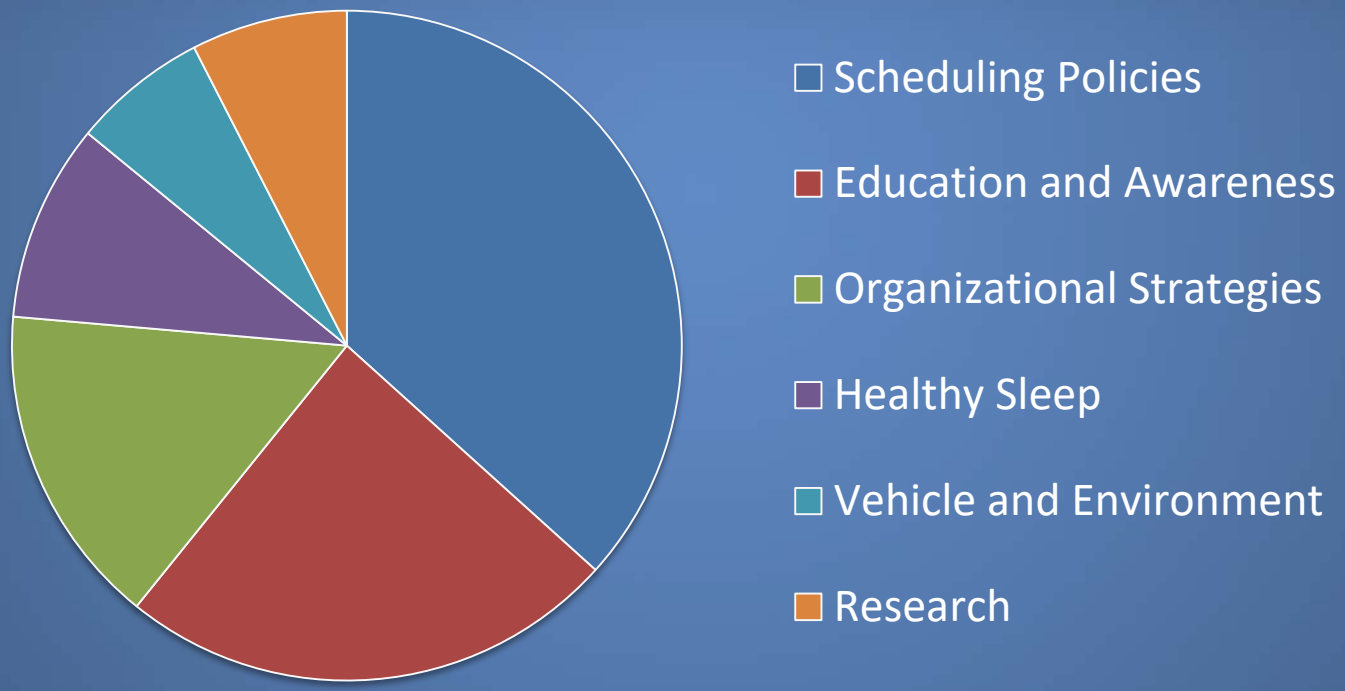
NTSB 101

- Independent federal agency, investigate transportation accidents/crashes, all modes
- Determine probable cause(s) and make recommendations to prevent recurrences
- Issue safety studies/special investigation reports
- Primary product: Safety recommendations
  - > 80% favorably received, even though implementation is not mandatory
- *SINGLE FOCUS IS SAFETY*

Challenges of Fatigue

- Difficult to measure
  - Arriving at work
  - While on duty
  - After accident
- Not well understood
  - Most understood: Sleep deprivation
  - Not so well understood: Effects of age, weight, diet, exercise, smoking, drinking, stress?
- Self-diagnosis is not reliable

Much More Than Rest and Duty Time

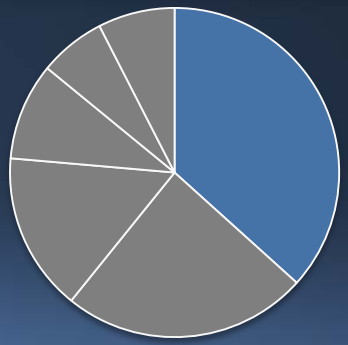


NTSB

NTSB Recommendations Regarding Fatigue

- Most accidents investigated by the NTSB involve commercial transportation
- The disconnect: Most commercial transportation is 24/7, humans are not
- In 20% of major NTSB investigations (in all transportation modes), fatigue is a cause, contributing factor, or finding
- *Very complex problem: Only 67% recommendation implementation rate*

Scheduling Policies

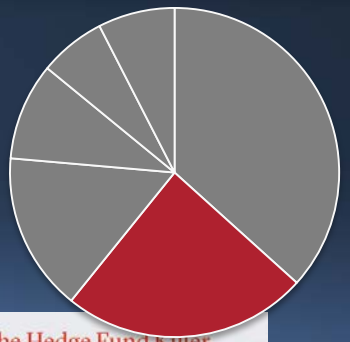


- Progress:
  - 14 CFR Part 117 flightcrew duty and rest requirements
  - Electronic logging device requirement for truck and bus drivers
- Still Needed:
  - Science-based duty hours regulations for all safety-sensitive transportation work
  - Inclusion of cargo pilots in Part 117

Why Scheduling Is Not Enough

- Collision on New Jersey Turnpike, cars slowed for construction
- Truck driver struck limo-van; had been awake for 28 hours
  - Overnight drive from Georgia to pick up his truck in Wilmington, DE, where he was based
- Brakes applied only 2 seconds before impact
- On duty for 13 ½ hours of a 14-hour duty – *within rest and duty rules*

Education and Awareness



- Progress:
  - More resources available
  - Greater awareness of fatigue in general and fatigue as a safety issue (evolved from “diet and exercise” to “diet, exercise, and sleep”)
- Still Needed:
  - Improved outreach to high-risk populations

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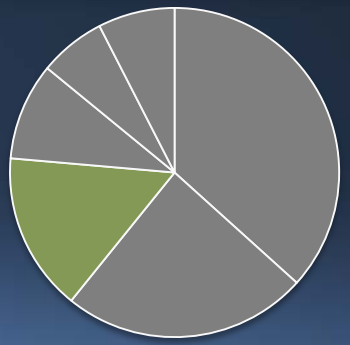
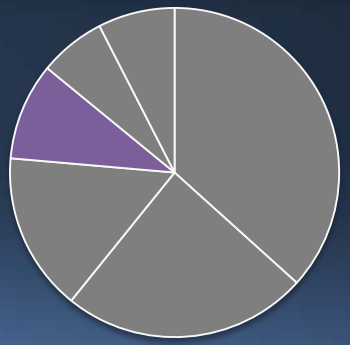
Organizational Strategies



- Progress:
  - More industries/companies adopting fatigue risk management systems (FRMS)
  - Use of science-based tools for fatigue risk management
  - Non-punitive call-in fatigued policies
- Still Needed:
  - Increased FRMS adoption
  - Not just creation but actual implementation

Healthy Sleep



- Progress:
  - Companies with OSA screening and treatment
  - Medical examiner requirements
- Still Needed:
  - Better rules and guidance for screening and treating sleep disorders
  - Guidance on how drugs affect alertness

Sleep Apnea

- Associated with Body Mass Index (BMI)
- Americans are gaining weight
- Often undiagnosed
- Often hidden, even if diagnosed
- Often inadequately treated

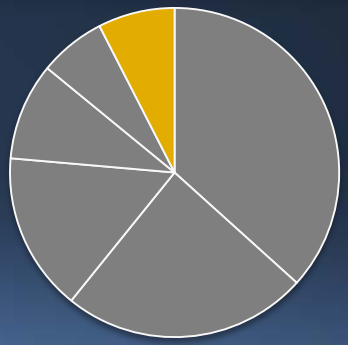
The Good News: A Win-Win

- Obstructive sleep apnea is treatable
- Experience has shown that when OSA is identified and treated
  - Safety improves
  - Driver quality of life and morale improve
  - Turnover decreases
  - Training costs decrease

Vehicle and Environment

- Progress:
  - Rumble strips, lane departure warning systems, collision avoidance systems, positive train control
- Still Needed:
  - Validation of emerging technologies
  - Widespread adoption of technologies that work

Research



- Progress:
  - Well-developed understanding of the issues regarding sleep and sleep disorders
- Still Needed:
  - More research on the efficacy of various countermeasures
  - Better understanding of related issues, e.g., age, weight, diet, exercise, smoking behavior, drinking behavior, stress

Fatigue: UPS 1354, Birmingham

- Nonprecision approach, IMC, requires extra vigilance
- Captain did not call for and first officer did not verify the approach
  - Approach not correctly entered, vertical guidance provided was meaningless
- Captain did not descend to the FAF minimum crossing altitude
- Crew did not monitor flightpath or recognize several cues that approach not set up properly

Flight Crew Performance

- Crew did not follow SOPs
  - Continued unstable approach
  - Did not recognize at minimum altitude
  - First officer did not make required minimum altitude callouts
  - Expectation of higher ceiling
  - Captain descended below minimums

Fatigue - Captain

- Off duty August 5-12
- Took steps to mitigate effects of fatigue
  - Aug. 12: Napped at home and acquired sleep room in Louisville
  - Aug. 13: Adequate opportunity to rest in Rockford
  - Aug. 14: Acquired sleep room in Louisville
- Accident occurred during window of circadian low

Fatigue – First Officer

- Off duty August 10-12
- Mismanaged off duty time
  - Aug. 12: returned to duty with about a 3 hour sleep debt
  - August 13: less than 5 ½ hour sleep opportunity
  - August 14: acquired sleep room in Louisville
- Aware of fatigued state

NTSB Findings

- Crew's fatigue due to circadian factors and first officer's acute sleep loss
- Crew's expectation of visual meteorological conditions
- First officer's increased workload

Fatigue: Santa Fe Rescue Flight

- Decision to take off in adverse conditions:
  - Darkness
  - Low ceiling
  - Mixed precipitation
  - High wind
  - Surrounding terrain

Fatigue factors – Duty day

- Monday, June 8, 2009
  - Early shift 0300-1100
- Tuesday, June 9, 2009
  - Routine shift 0700-1500
  - After another pilot unavailable, worked extra shift 1756-2135
  - (11 hours 41 mins duty day)

Probable Cause

"The pilot's decision to take off from a remote, mountainous landing site in dark (moonless) night, windy, IMC conditions. Contributing to the accident were an organizational culture that prioritized mission execution over aviation safety and the **pilot's fatigue**, self-induced pressure to conduct the flight, and situational stress. Also contributing were deficiencies in the NMSP aviation section's safety-related policies, including …**lack of an effective fatigue management program for pilots**…."

Fatigue: Helicopter Maintenance

- Wreckage examination
  - Flight control input rod separated from hydraulic servo
  - Bolt, washer, nut, and cotter pin used to secure rod to servo not located

What went wrong?

- Post-crash testing
  - Disengagement of fore/aft servo bolt
  - Hardware improperly installed
  - Specifically, cotter pin not installed or installed incorrectly

Mechanic and Inspector Performance

- Mechanic stated he reused nut then torqued and safetied everything, including cotter pin
- Inspector found no problems during inspections
- Check pilot found loose hydraulic belt

Maintenance Personnel Fatigue

Personnel	Normal Shift	Scheduled Shift on Dec. 6	Actual Shift on Dec. 6	Duty Length	Time Awake	Sleep Debt
Mechanic	Noon to 2300	Off duty	0550 to 1846	12:56	13:46	3:00
Inspector	Noon to 2300	Off duty	0531 to 1855	13:24	14:55	1:30

Probable Cause

Sundance Helicopters' inadequate maintenance of the helicopter…which resulted in the in-flight separation of the servo control input rod from the fore/aft servo and rendered the helicopter uncontrollable. Contributing to the improper or lack of installation of the split pin was the **mechanic's fatigue** and the lack of clearly delineated maintenance task steps to follow. Contributing to the inadequate postmaintenance inspection was the **inspector's fatigue** and the lack of clearly delineated inspection steps to follow.

Sleep Apnea: Recent Examples

- Bronx, NY, 2013, Commuter rail derailed going 80 mph on 30 mph curve; engineer's undiagnosed sleep apnea
- Hoxie, AK, 2014, Freight train ran red signal, collided with oncoming freight train, engineer's inadequately treated sleep apnea (and conductor's irregular work schedule)
- Palm Springs, CA, 2016, Truck driver likely fell asleep, due to undiagnosed obstructive sleep apnea, during brief traffic stop. The stopped truck was struck by a bus after traffic flow resumed.
- Investigating engineer sleep apnea in commuter rail accidents in
  - Atlantic Terminal, Brooklyn, NY, 2017
  - Hoboken (NJ) Terminal, 2016

Sleep Apnea: Hilo, HI

- 20 minutes into 30 minute flight, no radio communications with ATC
- Overflew destination by 26 miles
- Captain reported “the warm Hawaiian sun was blaring in…I…closed my eyes for a minute, enjoying the sunshine, and dozed off.”

Fatigue factors

- Trip schedule
  - Early start times
  - Demanding flight sequences
- Task/environment factors
  - Cruise phase/low workload
  - Warm, sunny cockpit
- Undiagnosed sleep apnea (captain)

Probable cause

The captain and first officer inadvertently falling asleep during the cruise phase of flight. Contributing to the incident were the captain's undiagnosed obstructive sleep apnea and the flight crew’s recent work schedules, which included several consecutive days of early-morning start times.

Conclusions

- Fatigue is a complex multi-faceted issue
- Continuing problem in every mode of transportation
- No silver bullet
- Necessitates vigilance from everyone

Thank You!!

Questions?

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